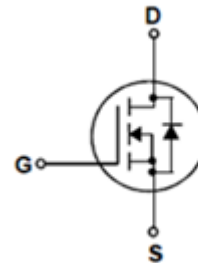
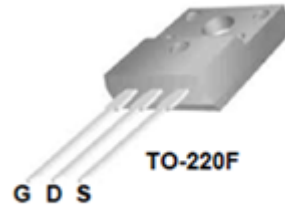


## 650V N-Channel MOSFET

### General Description

This Power MOSFET is produced using advanced planar stripe DMOS technology. This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode.

These devices are well suited for high efficiency switched mode power supplies, active power factor correction based on half bridge topology.



### Features

13A, 650V,  $R_{DS(on)typ.} = 0.6\Omega @ V_{GS} = 10V$

Smart design in high voltage technology

Ultra low gate charge

Fast switching

Low reverse recovery charge.

Improved  $dv/dt$  capability

### Absolute Maximum Ratings $T_c = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	JFFC13N65D	Units
$V_{DSS}$	Drain – Source Voltage	650	V
$I_D$	Drain Current	Continuous ( $T_c = 25^\circ\text{C}$ )	13*
		Continuous ( $T_c = 100^\circ\text{C}$ )	7.5*
$I_{DM}$	Drain Current - Pulsed ( Note 1 )	48	A
$V_{GSS}$	Gate – Source Voltage	$\pm 30$	V
EAS	Single Pulsed Avalanche Energy ( Note 2 )	230	mJ
$I_{AR}$	Avalanche Current ( Note 1 )	13	A
$E_{AR}$	Repetitive Avalanche Energy ( Note 1 )	26	mJ
$dv/dt$	Peak Diode Recovery $dv/dt$ ( Note 3 )	4.5	V/ns
$P_D$	Power Dissipation ( $T_c = 25^\circ\text{C}$ ) -Derate above $25^\circ\text{C}$	42	W
		0.34	W/ $^\circ\text{C}$
$T_J, T_{STG}$	Operating and Storage Temperature Range	-55 to +150	$^\circ\text{C}$
$T_L$	Maximum lead temperature for soldering purposes 1/8" from case for 5 seconds	300	$^\circ\text{C}$

\*Drain current limited by maximum junction temperature.

## Thermal characteristics

Symbol	Parameter	JFFC13N65D	Units
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	2.98	$^{\circ}\text{C}/\text{W}$
$R_{\theta JS}$	Thermal Resistance, Case-to-Sink Typ.	--	$^{\circ}\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62.5	$^{\circ}\text{C}/\text{W}$

## Electrical Characteristics $T_c = 25^{\circ}\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
<b>Off Characteristics</b>						
$BV_{DSS}$	Drain – Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	650	--	--	V
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250\ \mu\text{A}$ , Referenced to $25^{\circ}\text{C}$	--	0.6	--	$\text{V}/^{\circ}\text{C}$
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$ $V_{DS} = 520\text{ V}, T_c = 125^{\circ}\text{C}$	--	--	1 10	$\mu\text{A}$ $\mu\text{A}$
$I_{GSSF}$	Gate-Body Leakage Current, Forward	$V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$	--	--	100	nA
$I_{GSSR}$	Gate-Body Leakage Current, Reverse	$V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$	--	--	-100	nA
<b>On Characteristics</b>						
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	2.0	--	4.0	V
$R_{DS(on)}$	Static Drain-Source on-Resistance	$V_{GS} = 10\text{ V}, I_D = 6.5\text{ A}$	--	0.6	0.75	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 40\text{ V}, I_D = 6.5\text{ A}$ ( Note 4 )	--	11	--	S
<b>Dynamic Characteristics</b>						
$C_{iss}$	Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$	--	1600	--	pF
$C_{oss}$	Output Capacitance		--	135	--	pF
$C_{rss}$	Reverse Transfer Capacitance		--	14	--	pF
<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Delay Time	$V_{DS} = 325\text{ V}, I_D = 13.0\text{ A}, R_G = 25\ \Omega, V_{GS} = 10\text{ V}$ ( Note 4,5 )	--	30	--	ns
$t_r$	Turn-On Rise Time		--	25	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	60	--	ns
$t_f$	Turn-Off Fall Time		--	40	--	ns
$Q_g$	Total Gate Charge	$V_{DS} = 520\text{ V}, I_D = 13.0\text{ A}, V_{GS} = 10\text{ V}$ ( Note 4,5 )	--	47	--	nC
$Q_{gs}$	Gate-Source Charge		--	10	--	nC
$Q_{gd}$	Gate-Drain Charge		--	16.5	--	nC
<b>Drain – Source Diode Characteristics and Maximum Ratings</b>						
$I_S$	Maximum Continuous Drain-Source Diode Forward Current		--	--	13	A
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current		--	--	52	A
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 13.0\text{ A}$	--	--	1.4	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0\text{ V}, I_S = 13.0\text{ A}$	--	500	--	ns
$Q_{rr}$	Reverse Recovery Charge	$di_F/dt = 100\text{ A}/\mu\text{s}$ ( Note 4 )	--	5.6	--	$\mu\text{C}$

### Notes:

1. Repetitive Rating : Pulsed width limited by maximum junction temperature
2.  $L = 3.0\text{ mH}, I_{AS} = 13\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\ \Omega$ , Starting  $T_J = 25^{\circ}\text{C}$
3.  $I_{SD} \leq 13.0\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^{\circ}\text{C}$
4. Pulsed Test : Pulsed width  $\leq 300\ \mu\text{s}$ , Duty cycle  $\leq 2\%$
5. Essentially independent of operating temperature

## Typical Characteristics

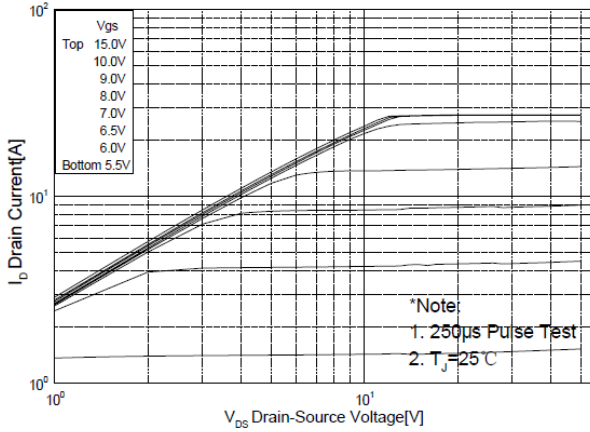


Figure 1. On-Region Characteristics

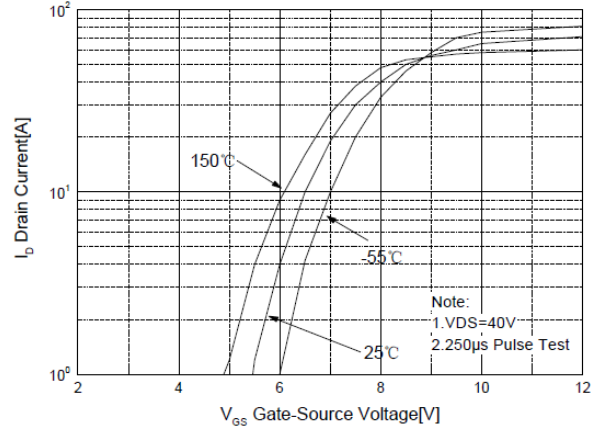


Figure 2. Transfer Characteristics

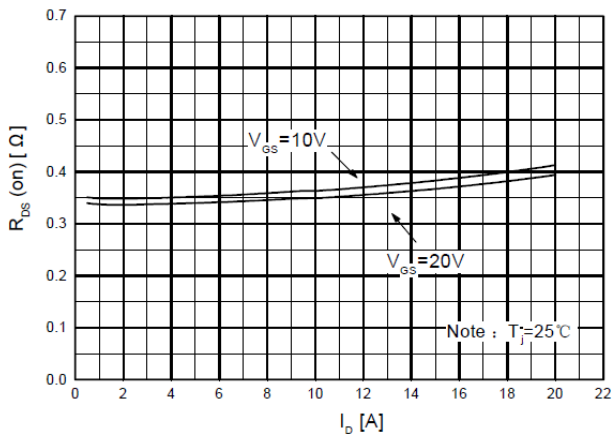


Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

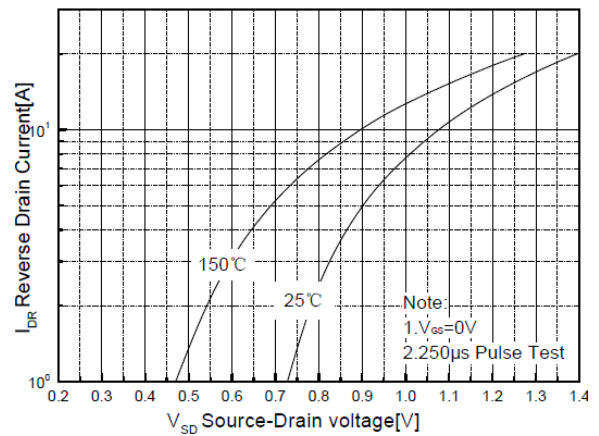


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

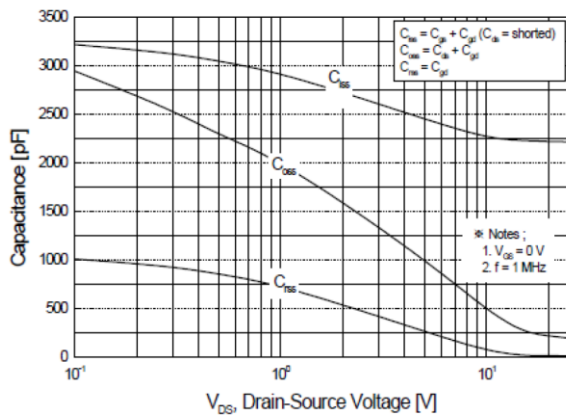


Figure 5. Capacitance Characteristics

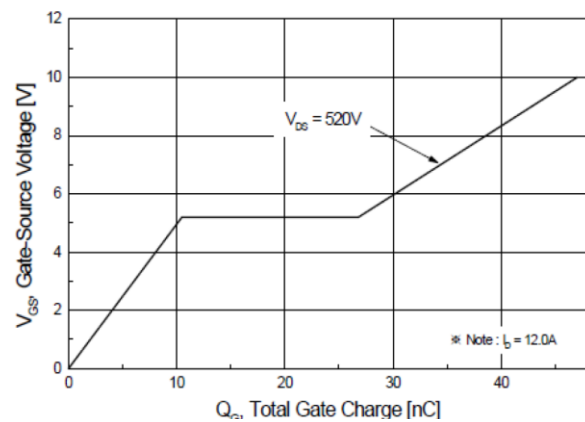


Figure 6. Gate Charge Characteristics

### Typical Characteristics

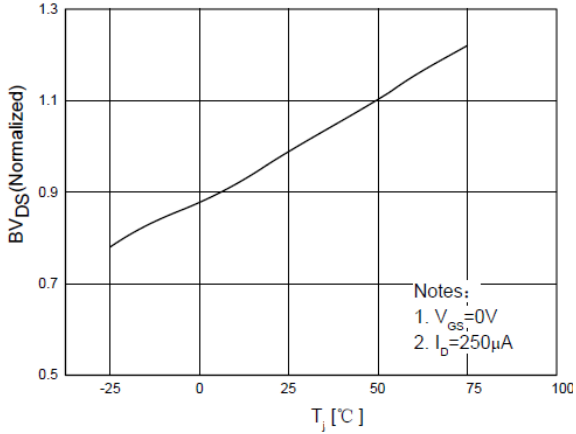


Figure 7. Breakdown Voltage Variation vs Temperature

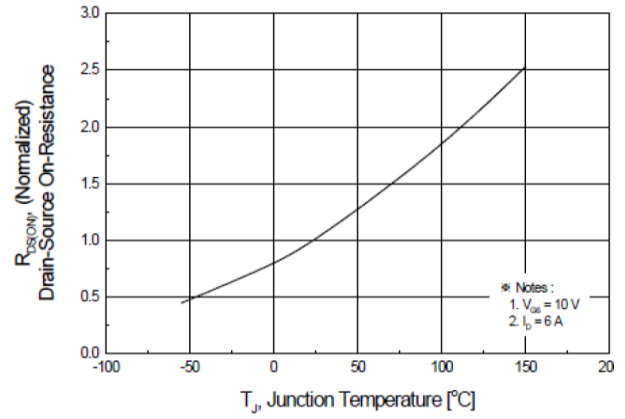


Figure 8. On-Resistance Variation vs Temperature

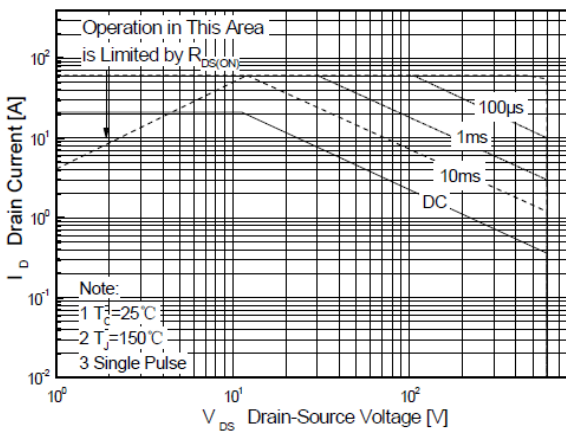


Figure 9-2. Maximum Safe Operating Area for JFFC13N65D

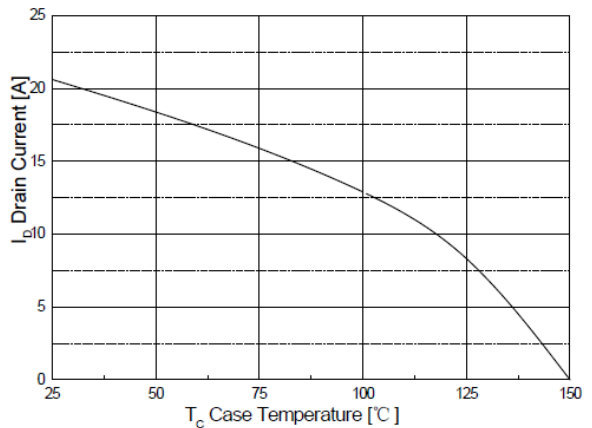


Figure 10. Maximum Drain Current vs Case Temperature

Typical Characteristics

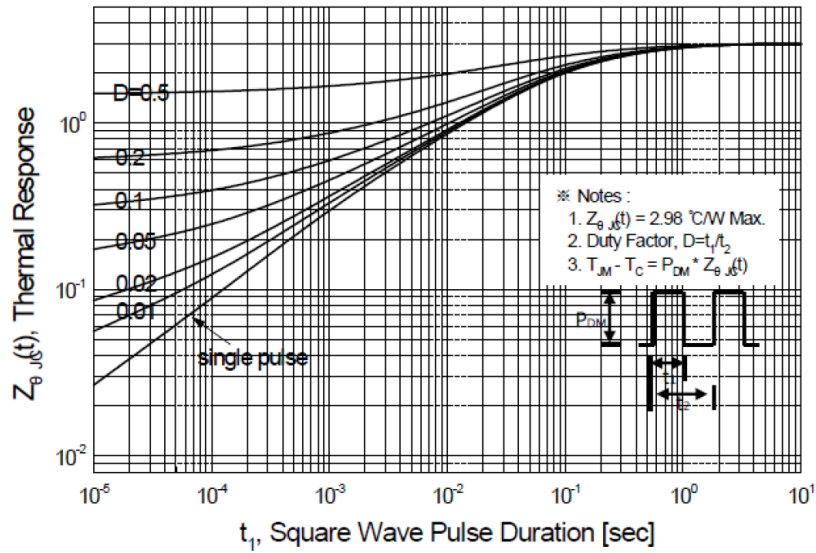
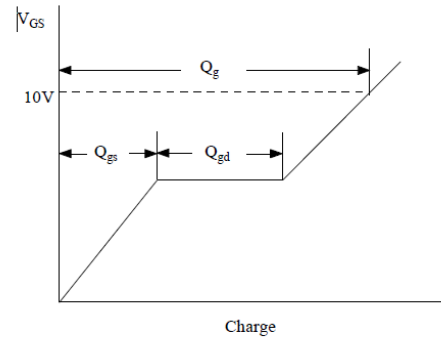
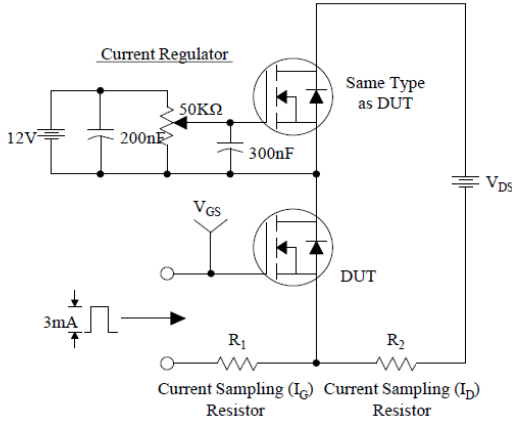
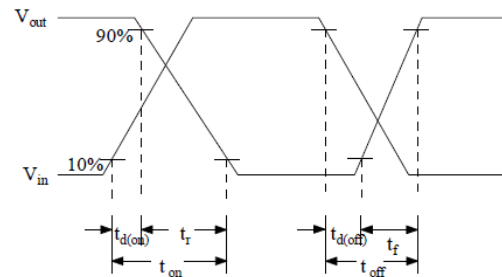
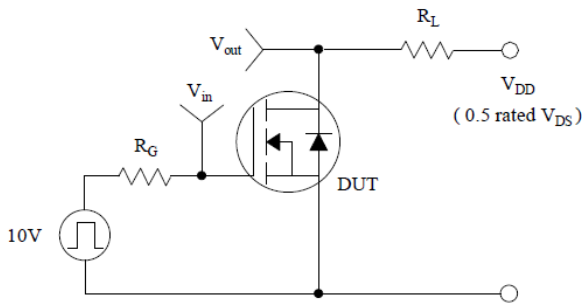


Figure 11-2. Transient Thermal Response Curve for JFFC13N65D

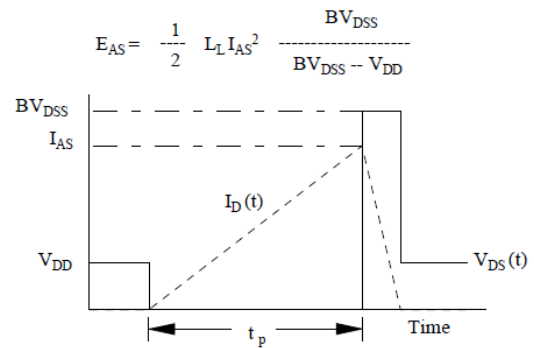
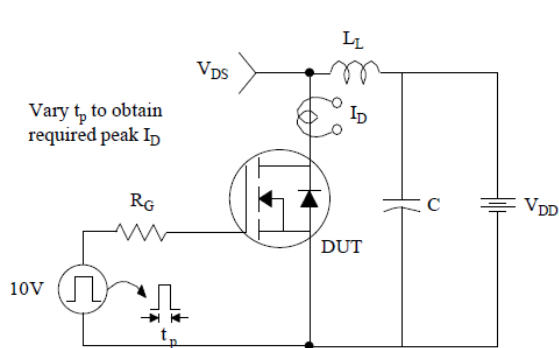
### Test Circuit & Waveform



Gate Charge Test Circuit & Waveform

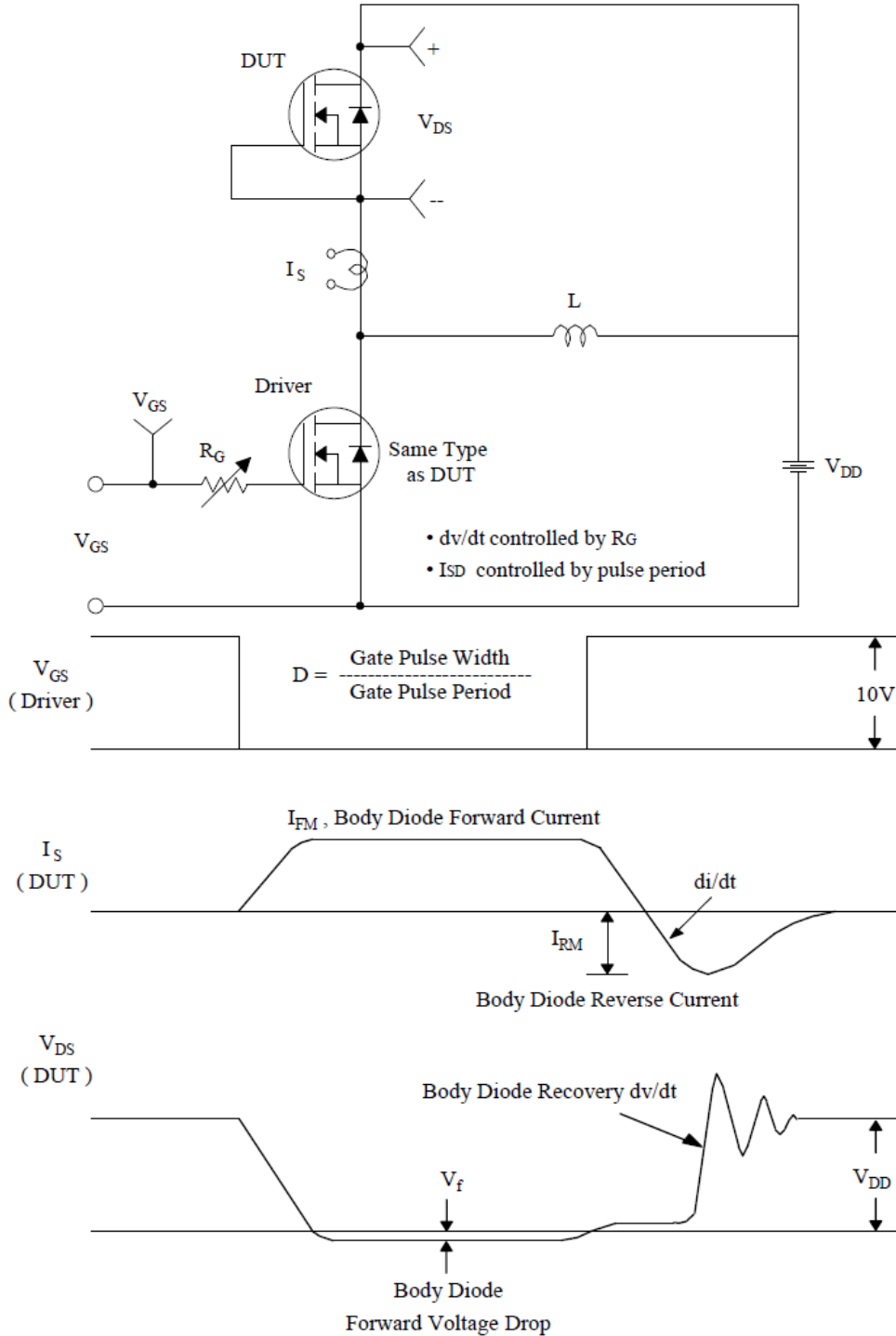


Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms

### Test Circuit & Waveform



Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms